CLAIMS

What is claimed is:

1. An apparatus for storing data, said apparatus comprising:

a fixed electrode electrically coupled to

a storage medium having a plurality of different and distinguishable oxidation states wherein data is stored in said oxidation states by the addition or withdrawal of one or more electrons from said storage medium via the electrically coupled electrode;

said storage medium comprising a storage molecule having a plurality of different and distinguishable oxidation states wherein said storage molecule comprises a first triple-decker sandwich coordination compound covalently linked to a second triple-decker sandwich coordination compound wherein the first compound and the second compound are different triple-decker sandwich coordination compounds.

2. The apparatus of claim 1, wherein said storage molecule comprises a heteroleptic sandwich coordination compound.

3. The apparatus of claim 1, wherein said storage molecule comprises a homoleptic sandwich coordination compound.

4. The apparatus of claim 1, wherein said storage molecule comprises a triple decker sandwhich coordination compound having a formula selected from the group consisting of $\mathrm{Por^1M^1Por^2M^2Por^3}$, $\mathrm{Por^1M^1Pc^1M^2Por^2}$, $\mathrm{Pc^1M^1Pc^2M^2Por^1}$, $\mathrm{Pc^1M^1Pc^2M^2Pc^3}$, $\mathrm{Pc^1M^1Por^1M^2Por^2}$, and $\mathrm{Pc^1M^1Por^1M^2Pc^2}$ wherein:

$\mathrm{M^1}$, and $\mathrm{M^2}$ are the same or different and each is a metal;

$\mathrm{Por^1}$, $\mathrm{Por^2}$, and $\mathrm{Por^3}$ are the same or different and each is a porphyrinato species; and

$\mathrm{Pc^1}$, $\mathrm{Pc^2}$, and $\mathrm{Pc^3}$ are the same or different and each is a phthalocyaninato species.

5. The apparatus of claim 4, wherein $\mathrm{M^1}$ and $\mathrm{M^2}$, when present, are independently selected from metals of the lanthanide series.

6. The apparatus of claim 4, wherein said storage molecule has a vertical architecture.

7. The apparatus of claim 4, wherein said storage molecule has a horizontal architecture.

8. The apparatus of claim 7, wherein said storage molecule is covalently coupled to said electrode by at least two linkers.

9. The apparatus of claim 4, wherein said storage molecule comprises a triple-decker sandwich coordination compound having the formula:

$$Por^1Ln^1Pc^1Ln^2Por^2$$

wherein:

Por^1 and Por^2 are the same or different and are each a porphyrinato species;

Ln^1 and Ln^2 are the same or different and each is a lanthanide;

Pc^1 is a phthalocyaninato species; and

said storage molecule has at least 8 different and distinguishable non-zero oxidation states.

10. The apparatus of claim 4, wherein said storage molecule comprises a triple-decker sandwich coordination compound having the formula:

$$Pc^1Ln^1Por^1Ln^2Pc^2$$

wherein:

Por^1 is a porphyrinato species;

Ln^1 and Ln^2 are the same or different and each is a lanthanide;

Pc^1 and Pc^2 are the same or different and each is a phthalocyaninato species; and

said storage molecule has at least 8 different and distinguishable non-zero oxidation states.

11. The apparatus of claim 4, wherein said storage molecule comprises a triple-decker sandwich coordination compound having the formula:

$$Pc^1Ln^1Pc^2Ln^2Por^1$$

wherein:

Por^1 is porphyrinato species;

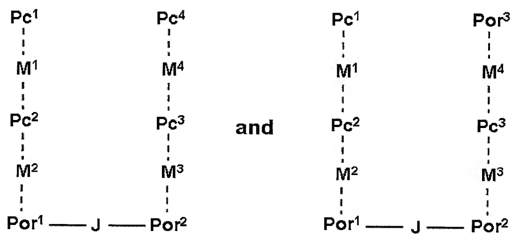
Ln^1 and Ln^2 are the same or different and each is a lanthanide;

Pc^1 and Pc^2 are the same or different and each is a phthalocyaninato species; and

said storage molecule has at least 8 different and distinguishable non-zero oxidation states.

12. The apparatus of any one of claims 4, 10, 11, wherein Ln is selected from the group consisting of Eu, and Ce.

13. The apparatus of claim 4, wherein said storage molecule has a formula selected from the group consisting of:



wherein

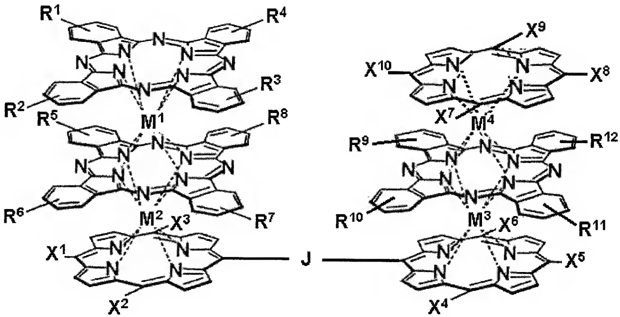
M^1, M^2, M^3, and M^4 are metals independently selected from the lanthanide series or the actinide series;

Por^1, Por^2, Por^3 are are the same or different and each is a porphyrinato species;

Pc^1, Pc^2, Pc^3, and Pc^4 are the same or different and are each phthalocyaninato species; and

J is a covalent bond or a linker.

14. The apparatus of claim 13, wherein said storage molecule has a formula:



wherein:

$R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9, R^{10}, R^{11}$, and R^{12} are independently selected from the group consisting of a covalent bond, a linker, aryl, phenyl, cycloalkyl, alkyl, halogen, alkoxy, alkylthio, perfluoroalkyl, perfluoroaryl, pyridyl, cyano, thiocyanato, nitro, amino, alkylamino, acyl, sulfoxyl, sulfonyl, amido, and carbamoyl;

$X^1, X^2, X^3, X^4, X^5, X^6, X^7, X^8, X^9$, and X^{10} are independently selected from the group consisting of a covalent bond, a linker, aryl, phenyl, cycloalkyl, alkyl, halogen, alkoxy, alkylthio, perfluoroalkyl, perfluoroaryl, pyridyl, cyano, thiocyanato, nitro, amino, alkylamino, acyl, sulfoxyl, sulfonyl, amido, and carbamoyl;

at least one R or X is a covalent bond or a linker;

J is a covalent bond or a linker; and

M^1, M^2, M^3, and M^4 are independently selected metals from the lanthanide series.

15. The apparatus of claim 14, wherein $R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9, R^{10}, R^{11}$, and R^{12} are independently selected from the group consisting of a linker, methyl, *t*-butyl, butoxy, fluoro, and H.

16. The apparatus of claim 14, wherein $X^1, X^2, X^3, X^4, X^5, X^6, X^7, X^8, X^9$, and X^{10} are independently selected from the group consisting of a linker, 4-methylphenyl, 4-*t*-butylphenyl, 4-trifluoromethylphenyl, pentyl, and H.

17. The apparatus of claim 14, wherein M^1, M^2, and M^4 are the same.

18. The apparatus of claim 14, wherein M^1, M^2, and M^4 are Eu, and M^3 is Ce.

19. The apparatus of claim 14, wherein R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9, R^{10}, R^{11}, and R^{12} are the same.

20. The apparatus of claim 14, wherein X^5 is a linker.

21. The apparatus of claim 14, wherein X^3 and X^4 are linkers.

22. The apparatus of claim 14, wherein X^2 and X^4 are linkers.

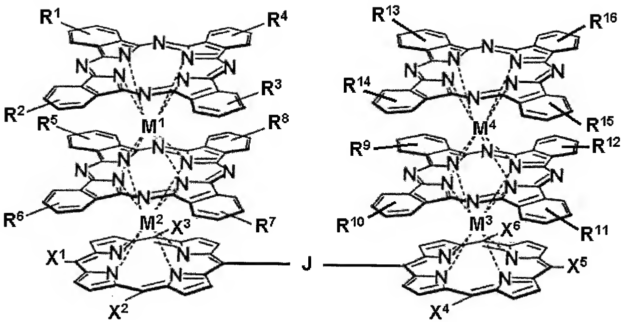
23. The apparatus of claim 14, wherein X^1, X^2, and X^3 are the same, and X^5 is a linker.

24. The apparatus of any one of claims 20 through 23, wherein said linker is selected from the goup consisting of 4-carboxyphenyl, 2-(4-carboxyphenyl)ethynyl, 4-(2-(4-carboxyphenyl)ethynyl)phenyl, 4-carboxymethylphenyl, 4-(2-(4-carboxymethylphenyl)ethynyl)phenyl, 4-hydroxyphenyl, 2-(4-hydroxyphenyl)ethynyl, 4-(2-(4-hydroxyphenyl)ethynyl)phenyl, 4-hydroxymethylphenyl, 4-(2-(4-hydroxymethylphenyl)ethynyl)phenyl, 4-mercaptophenyl, 2-(4-mercaptophenyl)ethynyl, 4-(2-(4-mercaptophenyl)ethynyl)phenyl, 4-mercaptomethylphenyl, 4-(2-(4-mercaptomethylphenyl)ethynyl)phenyl, 4-selenylphenyl, 2-(4-selenylphenyl)ethynyl, 4-selenylmethylphenyl, 4-(2-(4-selenylphenyl)ethynyl)phenyl, 4-tellurylphenyl, 2-(4-tellurylphenyl)ethynyl, 4-(2-(4-tellurylphenyl)ethynyl)phenyl, 4-tellurylmethylphenyl, and 4-(2-(4-tellurylmethylphenyl)ethynyl)phenyl.

25. The apparatus of claim 14, wherein J is a linker selected from the group consisting of 4,4′-diphenylethyne, 4,4′-diphenylbutadiyne, 4,4′-biphenyl, 1,4-phenylene, 4,4′-stilbene, 1,4-bicyclooctane, 4,4′-azobenzene, 4,4′-benzylideneaniline, and 4,4″-terphenyl.

26. The apparatus of claim 14, wherein said storage molecule has the formula of a dyad selected from the group consisting of dyad2, dyad3, dyad4, and dyad5.

27. The apparatus of claim 13, wherein said storage molecule has a formula:



wherein:

R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9, R^{10}, R^{11}, R^{12}, R^{13}, R^{14}, R^{15}, and R^{16} are selected from the group consisting of a covalent bond, a linker, aryl, phenyl, cycloalkyl, alkyl, halogen, alkoxy, alkylthio, perfluoroalkyl, perfluoroaryl, pyridyl, cyano, thiocyanato, nitro, amino, alkylamino, acyl, sulfoxyl, sulfonyl, amido, a and carbamoyl;

X^1, X^2, X^3, X^4, X^5, and X^6 are independently selected from the group consisting of a covalent bond, a linker, aryl, phenyl, cycloalkyl, alkyl, halogen, alkoxy, alkylthio, perfluoroalkyl, perfluoroaryl, pyridyl, cyano, thiocyanato, nitro, amino, alkylamino, acyl, sulfoxyl, sulfonyl, amido, and carbamoyl;

at least one R or X is a covalent bond or a linker;

J is a covalent bond or a linker; and

M^1, M^2, M^3, and M^4 are independently selected metals from the lanthanide series.

28. The apparatus of claim 27, wherein R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9, R^{10}, R^{11}, R^{12}, R^{13}, R^{14}, R^{15}, and R^{16} are independently selected from the group consisting of a linker, methyl, *t*-butyl, butoxy, fluoro, and H.

29. The apparatus of claim 27, wherein X^1, X^2, X^3, X^4, X^5, and X^6 are independently selected from the group consisting of a linker, 4-methylphenyl, 4-*t*-butylphenyl, 4-trifluoromethylphenyl, pentyl, and H.

30. The apparatus of claim 27, wherein M^1, M^2, and M^4 are the same.

31. The apparatus of claim 27, wherein M^1, M^2, and M^4 are Eu, and M^3 is Ce.

32. The apparatus of claim 27, wherein R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9, R^{10}, R^{11}, R^{12}, R^{13}, R^{14}, R^{15}, and R^{16} are the same.

33. The apparatus of claim 27, wherein X^5 is a linker.

34. The apparatus of claim 27, wherein X^3 and X^4 are linkers.

35. The apparatus of claim 27, wherein X^3 and X^4 are linkers.

36. The apparatus of claim 27, wherein X^1, X^2, and X^3 are the same, and X^5 is a linker.

37. The apparatus of any one of claims 33 through 36, wherein said linker is selected from the goup consisting of 4-carboxyphenyl, 2-(4-carboxyphenyl)ethynyl, 4-(2-(4-carboxyphenyl)ethynyl)phenyl, 4-carboxymethylphenyl, 4-(2-(4-carboxymethylphenyl)ethynyl)phenyl, 4-hydroxyphenyl, 2-(4-hydroxyphenyl)ethynyl, 4-(2-(4-hydroxyphenyl)ethynyl)phenyl, 4-hydroxymethylphenyl, 4-(2-(4-hydroxymethylphenyl)ethynyl)phenyl, 4-mercaptophenyl, 2-(4-mercaptophenyl)ethynyl, 4-(2-(4-mercaptophenyl)ethynyl)phenyl, 4-mercaptomethylphenyl, 4-(2-(4-mercaptomethylphenyl)ethynyl)phenyl, 4-selenylphenyl, 2-(4-selenylphenyl)ethynyl, 4-selenylmethylphenyl, 4-selenylmethylphenyl, 4-(2-(4-selenylphenyl)ethynyl)phenyl, 4-tellurylphenyl, 2-(4-tellurylphenyl)ethynyl, 4-(2-(4-tellurylphenyl)ethynyl)phenyl, 4-tellurylmethylphenyl, and 4-(2-(4-tellurylmethylphenyl)ethynyl)phenyl.

38. The apparatus of claim 27, wherein J is a linker selected from the group consisting of 4,4′-diphenylethyne, 4,4′-diphenylbutadiyne, 4,4′-biphenyl, 1,4-

phenylene, 4,4′-stilbene, 1,4-bicyclooctane, 4,4′-azobenzene, 4,4′-benzylideneaniline, and 4,4″-terphenyl.

39. The apparatus of claim 27, wherein said storage molecule has the formula of dyad1.

40. The apparatus of claim 1, wherein said storage medium has a memory storage density of at least about 10 gigabits per cm^2 in a sheet-like device.

41. The apparatus of claim 1, wherein said storage medium is covalently linked to said electrode.

42. The apparatus of claim 1, wherein said storage molecule is covalently linked to said electrode by a thiol linker.

43. The apparatus of claim 1, wherein said storage molecule is covalently linked to said electrode by a linker wherein the coupling to the electrode has the form:

E-L-

where E is the electrode and L, before attachment to the electrode is a linker selected from the group consisting of 4-carboxyphenyl, 2-(4-carboxyphenyl)ethynyl, 4-(2-(4-carboxyphenyl)ethynyl)phenyl, 4-carboxymethylphenyl, 4-(2-(4-carboxymethylphenyl)ethynyl)phenyl, 4-hydroxyphenyl, 2-(4-hydroxyphenyl)ethynyl, 4-(2-(4-hydroxyphenyl)ethynyl)phenyl, 4-hydroxymethylphenyl, 4-(2-(4-hydroxymethylphenyl)ethynyl)phenyl, 4-mercaptophenyl, 2-(4-mercaptophenyl)ethynyl, 4-(2-(4-mercaptophenyl)ethynyl)phenyl, 4-mercaptomethylphenyl, 4-(2-(4-mercaptomethylphenyl)ethynyl)phenyl, 4-selenylphenyl, 2-(4-selenylphenyl)ethynyl, 4-selenylmethylphenyl, 4-(2-(4-selenylphenyl)ethynyl)phenyl, 4-tellurylphenyl, 2-(4-tellurylphenyl)ethynyl, 4-(2-(4-tellurylphenyl)ethynyl)phenyl, 4-tellurylmethylphenyl, and 4-(2-(4-tellurylmethylphenyl)ethynyl)phenyl.

44. The apparatus of claim 1, wherein said storage molecule is juxtaposed in the proximity of said electrode such that electrons can pass from said storage molecule to said electrode.

45. The apparatus of claim 1, wherein said storage medium is juxtaposed to a dielectric material embedded with counterions.

46. The apparatus of claim 1, wherein said storage medium and said electrode are fully encapsulated in an integrated circuit.

47. The apparatus of claim 1, wherein said storage medium is electronically coupled to a second electrode that is a reference electrode.

48. The apparatus of claim 1, wherein said storage medium is present on a single plane in said device.

49. The apparatus of claim 1, wherein said storage medium is present at a multiplicity of storage locations.

50. The apparatus of claim 1, wherein said apparatus comprises multiple planes and said storage locations are present on multiple planes of said apparatus.

51. The apparatus of claim 50, wherein said storage locations range from about 1024 to about 4096 different locations.

52. The apparatus of claim 50, wherein each location is addressed by a single electrode.

53. The apparatus of claim 50, wherein each location is addressed by at least two electrodes.

54. The apparatus of claim 1, wherein said electrode is connected to a voltage source.

55. The apparatus of claim 54, wherein said voltage source is the output of an integrated circuit.

56. The apparatus of claim 1, wherein said electrode is connected to a device to read the oxidation state of said storage medium.

57. The apparatus of claim 56, wherein said device is selected from the group consisting of a voltammetric device, an amperometric device, and a potentiometric device.

58. The apparatus of claim 57, wherein said device is a sinusoidal voltammeter.

59. The apparatus of claim 56, wherein said device provides a Fourier transform of the output signal from said electrode.

60. The apparatus of claim 56, wherein said device refreshes the oxidation state of said storage medium after reading said oxidation state.

61. The apparatus of claim 1, wherein said different and distinguishable oxidation states of said storage medium can be set by a voltage difference no greater than about 2 volts.

62. A method of storing data, said method comprising:

(i) providing an apparatus according to claim 1; and

(ii) applying a voltage to said electrode at sufficient current to set an oxidation state of said storage medium.

63. The method of claim 62, wherein said voltage ranges up to about 2 volts.

64. The method of claim 62, wherein said voltage is the output of an integrated circuit.

65. The method of claim 62, further comprising detecting the oxidation state of said storage medium and thereby reading out the data stored therein.

66. The method of claim 65, wherein said detecting the oxidation state of the storage medium further comprises refreshing the oxidation state of the storage medium.

67. The method of claim 65, wherein said detecting comprises analyzing a readout signal in the time domain.

68. The method of claim 65, wherein said detecting comprises analyzing a readout signal in the frequency domain.

69. The method of claim 65, wherein said detecting comprises performing a Fourier transform on said readout signal.

70. The method of claim 65, wherein said detecting utilizes a voltammetric method.

71. A porphyrin half-sandwich complex comprising a *cis*-A_2BC porphyrin complexed with a metal.

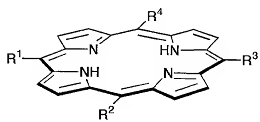
72. A method of making a triple-decker sandwich, said method comprising:

providing a metal-porphyrin half-sandwich complex comprising a *cis*-A_2BC type porphyrin complexed with a metal or an ABCD type porphyrin complexed with a metal; and

reacting said half-sandwich complex with a double-decker sandwich complex to form a triple-decker sandwich.

73. The method of claim 72, wherein said porphyrin is a *cis*-A_2BC type porphyrin.

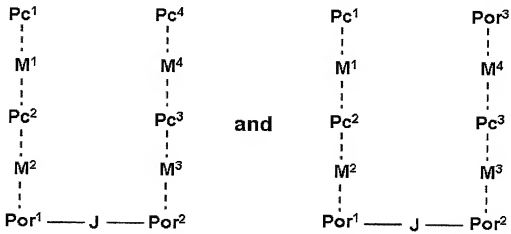
74. The method of claim 72, wherein said porphyrin has the formula:



wherein R^1, R^2, R^3, and R^4 are independently selected from the group consisting of *p*-tolyl, *n*-pentyl, 4-bromophenyl, 4-iodophenyl, trimethylsilylethynyl, bromo, iodo, 1,3,2-dioxaborolan-2-yl, 4-(1,3,2-dioxaborolan-2-yl)phenyl, 4-(2-trimethylsilylethynyl)phenyl, 4-formylphenyl, 4-aminophenyl, and 4-iodobicyclo[2.2.2]octan-1-yl.

75. The method of claim 72 wherein said double decker sandwich complex is selected from the group consisting of Por-M-Pc and Pc-M-Pc.

76. An information storage medium, said storage medium comprising a storage molecule having at least eight different and distinguishable non-zero oxidation states wherein said storage molecule has a formula selected from the group consisting of:



wherein

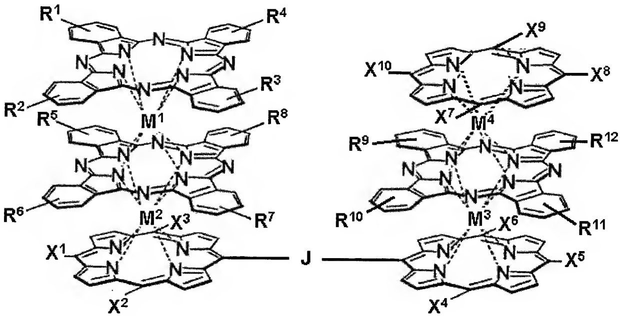
M^1, M^2, M^3, and M^4 are metals independently selected from the lanthanide series or the actinide series;

Por^1, Por^2, Por^3, and Por^4 are are the same or different and each is a porphyrinato species;

Pc^1, Pc^2, Pc^3, and Pc^4 are the same or different and are each phthalocyaninatol; and

J is a covalent bond or a linker.

77. The storage medium of claim 76, wherein said storage molecule has a formula:



wherein:

R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9, R^{10}, R^{11}, and R^{12} are independently selected from the group consisting of a covalent bond, a linker, aryl, phenyl, cycloalkyl, alkyl, halogen, alkoxy, alkylthio, perfluoroalkyl, perfluoroaryl, pyridyl, cyano, thiocyanato, nitro, amino, alkylamino, acyl, sulfoxyl, sulfonyl, amido, and carbamoyl;

X^1, X^2, X^3, X^4, X^5, X^6, X^7, X^8, X^9, and X^{10} are independently selected from the group consisting of a covalent bond, a linker, aryl, phenyl, cycloalkyl, alkyl, halogen, alkoxy, alkylthio, perfluoroalkyl, perfluoroaryl, pyridyl, cyano, thiocyanato, nitro, amino, alkylamino, acyl, sulfoxyl, sulfonyl, amido, and carbamoyl;

at least one R or X is a covalent bond or a linker;

J is a covalent bond or a linker; and

M^1, M^2, M^3, and M^4 are independently selected metals from the lanthanide series.

78. The storage medium of claim 77, wherein R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9, R^{10}, R^{11}, and R^{12} are independently selected from the group consisting of a linker, methyl, *t*-butyl, butoxy, fluoro, and H.

79. The storage medium of claim 77, wherein X^1, X^2, X^3, X^4, X^5, X^6, X^7, X^8, X^9, and X^{10} are independently selected from the group consisting of a linker, 4-methylphenyl, 4-*t*-butylphenyl, 4-trifluoromethylphenyl, pentyl, and H.

80. The storage medium of claim 77, wherein M^1, M^2, and M^4 are the same.

81. The storage medium of claim 77, wherein M^1, M^2, and M^4 are Eu, and M^3 is Ce.

82. The storage medium of claim 77, wherein R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9, R^{10}, R^{11}, and R^{12} are the same.

83. The storage medium of claim 77, wherein X^5 is a linker.

84. The storage medium of claim 77, wherein X^3 and X^4 are linkers.

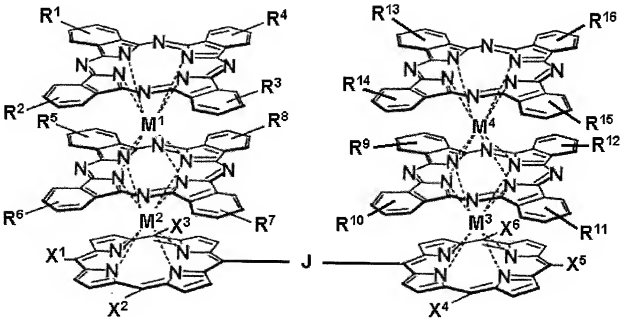
85. The storage medium of claim 77, wherein X^2 and X^4 are linkers.

86. The storage medium of claim 77, wherein X^1, X^2, and X^3 are the same, and X^5 is a linker.

87. The storage medium of claim 77, wherein J is a linker selected from the group consisting of 4,4′-diphenylethyne, 4,4′-diphenylbutadiyne, 4,4′-biphenyl, 1,4-phenylene, 4,4′-stilbene, 1,4-bicyclooctane, 4,4′-azobenzene, 4,4′-benzylideneaniline, and 4,4″-terphenyl.

88. The storage medium of claim 77, wherein said storage molecule has the formula of a dyad selected from the group consisting of dyad2, dyad3, dyad4, and dyad5.

89. The storage medium of claim 77, wherein said storage molecule has a formula:



wherein:

$R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9, R^{10}, R^{11}, R^{12}, R^{13}, R^{14}, R^{15}$, and R^{16} are selected from the group consisting of a covalent bond, a linker, aryl, phenyl, cycloalkyl, alkyl, halogen, alkoxy, alkylthio, perfluoroalkyl, perfluoroaryl, pyridyl, cyano, thiocyanato, nitro, amino, alkylamino, acyl, sulfoxyl, sulfonyl, amido, a and carbamoyl;

X^1, X^2, X^3, X^4, X^5, and X^6 are independently selected from the group consisting of a covalent bond, a linker, aryl, phenyl, cycloalkyl, alkyl, halogen, alkoxy, alkylthio, perfluoroalkyl, perfluoroaryl, pyridyl, cyano, thiocyanato, nitro, amino, alkylamino, acyl, sulfoxyl, sulfonyl, amido, and carbamoyl;

at least one R or X is a covalent bond or a linker;

J is a covalent bond or a linker; and

M^1, M^2, M^3, and M^4 are independently selected metals from the lanthanide series.

90. The storage medium of claim 89, wherein $R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9, R^{10}, R^{11}, R^{12}, R^{13}, R^{14}, R^{15}$, and R^{16} are independently selected from the group consisting of a linker, methyl, *t*-butyl, butoxy, fluoro, and H.

91. The storage medium of claim 89, wherein X^1, X^2, X^3, X^4, X^5, and X^6 are independently selected from the group consisting of a linker, 4-methylphenyl, 4-*t*-butylphenyl, 4-trifluoromethylphenyl, pentyl, and H.

92. The storage medium of claim 89, wherein M^1, M^2, and M^4 are the same.

93. The storage medium of claim 89, wherein M^1, M^2, and M^4 are Eu, and M^3 is Ce.

94. The storage medium of claim 89, wherein R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9, R^{10}, R^{11}, R^{12}, R^{13}, R^{14}, R^{15}, and R^{16} are the same.

95. The storage medium of claim 89, wherein X^5 is a linker.

96. The storage medium of claim 89, wherein X^3 and X^4 are linkers.

97. The storage medium of claim 89, wherein X^2 and X^4 are linkers.

98. The storage medium of claim 89, wherein X^1, X^2, and X^3 are the same, and X^5 is a linker.

99. The storage medium of claim 89, wherein J is a linker selected from the group consisting of 4,4′-diphenylethyne, 4,4′-diphenylbutadiyne, 4,4′-biphenyl, 1,4-phenylene, 4,4′-stilbene, 1,4-bicyclooctane, 4,4′-azobenzene, 4,4′-benzylideneaniline, and 4,4″-terphenyl.

100. The storage medium of claim 89, wherein said storage molecule has the formula of dyad1.

101. In a computer system, a memory device, said memory device comprising the apparatus of claim 1.

102. A computer system comprising a central processing unit, a display, a selector device, and a memory device, said memory device comprising the apparatus of claim 1.